



## **DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT**

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**NDGPS Site:** Penobscot, ME DGPS Site (799)  
**Inspector(s):** CWO3 Wayne Horn & CWO2 Marin Kaczmar  
**Date:** 14 Sep 2015

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### **REFERENCES**

- (1) Broadcast Standard for the USCG DGPS Navigation Service, CIM 16577.1 (APR 1993).
- (2) Radio Technical Commission for Maritime Services (RTCM) Recommended Standards for Differential Global Navigation Satellite System (GNSS) Service, Version 2.3.
- (3) Differential Global Positioning System (DGPS) Concept of Operations, COMDTINST 16577.2 (AUG 1995).
- (4) 2014 Federal Radio Navigation Plan.

### **PURPOSE**

- Validate advertised DGPS coverage of the Penobscot DGPS site.
- Validate required RTCM message scheduling and delivery.
- Test differential correction accuracy versus a predetermined survey monument.

### **EQUIPMENT**

Trimble SPS461 Receiver  
Trimble GA 530 Antenna  
Dell Latitude E3620 Laptop

### **PENOBSCOT DGPS SITE PARAMETERS**

Frequency	290 KHz
Forward Output Power	800 W
Transmission Rate	200 baud
Field Strength/Range	100 $\mu$ V/m (40 dB $\mu$ V/m) at 435 km

### **SUMMARY**

The Operational Assessment of the Penobscot DGPS site revealed that the provided coverage is not consistent with the advertised range. Signal strength and signal-to-noise ratio (SNR) reading were satisfactory throughout the majority of the advertised coverage area. However, the northeastern and southeastern regions fall short of meeting the advertised range; the likely cause being the dense granite mountain ranges that cover much of New England. In most cases, terrestrial masking would not impair the signal used to aid maritime transits. Both northern and southern far-field signal strength readings were within the required signal strength readings for the predicted coverage area. Additionally, a review of the output/reflected power and near-field signal strength levels was conducted and found to be satisfactory. All RTCM messages were verified, evaluated and are consistent with the requirements set forth by reference (1) and (2). Finally, accuracy measurements and analysis proved that at a distance of approximately 148 km from the broadcast site, the horizontal accuracy is sub-meter and within the accuracy

requirements set forth by Reference (3) and (4). Due to a Side B socket failure alarm, no side B signal strength or accuracy validations were recorded in this report.

**RESULTS**

***Signal Strength***

A verification of the Penobscot DGPS coverage area was conducted from the Connecticut/Rhode Island border northward along the coastline to US/Canada border at the Saint Croix River. The advertised signal strength range is 435 km. Figure 1 displays adequate signal strength, throughout the predicted coverage area. Green points represent areas of satisfactory signal strength, whereas areas of unsatisfactory signal strength are represented with red points. As seen in Table 1 and Table 2, far-field signal strength readings were taken at northern and southern points of the advertised range from both sides of the site. Both northern and southern far-field readings were usable but below the required 40 dBu V/m signal strength on both sides. The weakened signal strength is likely caused by the dense granite mountain ranges that cover much of New England. In most cases, terrestrial masking would not impair the signal used to aid maritime transit.

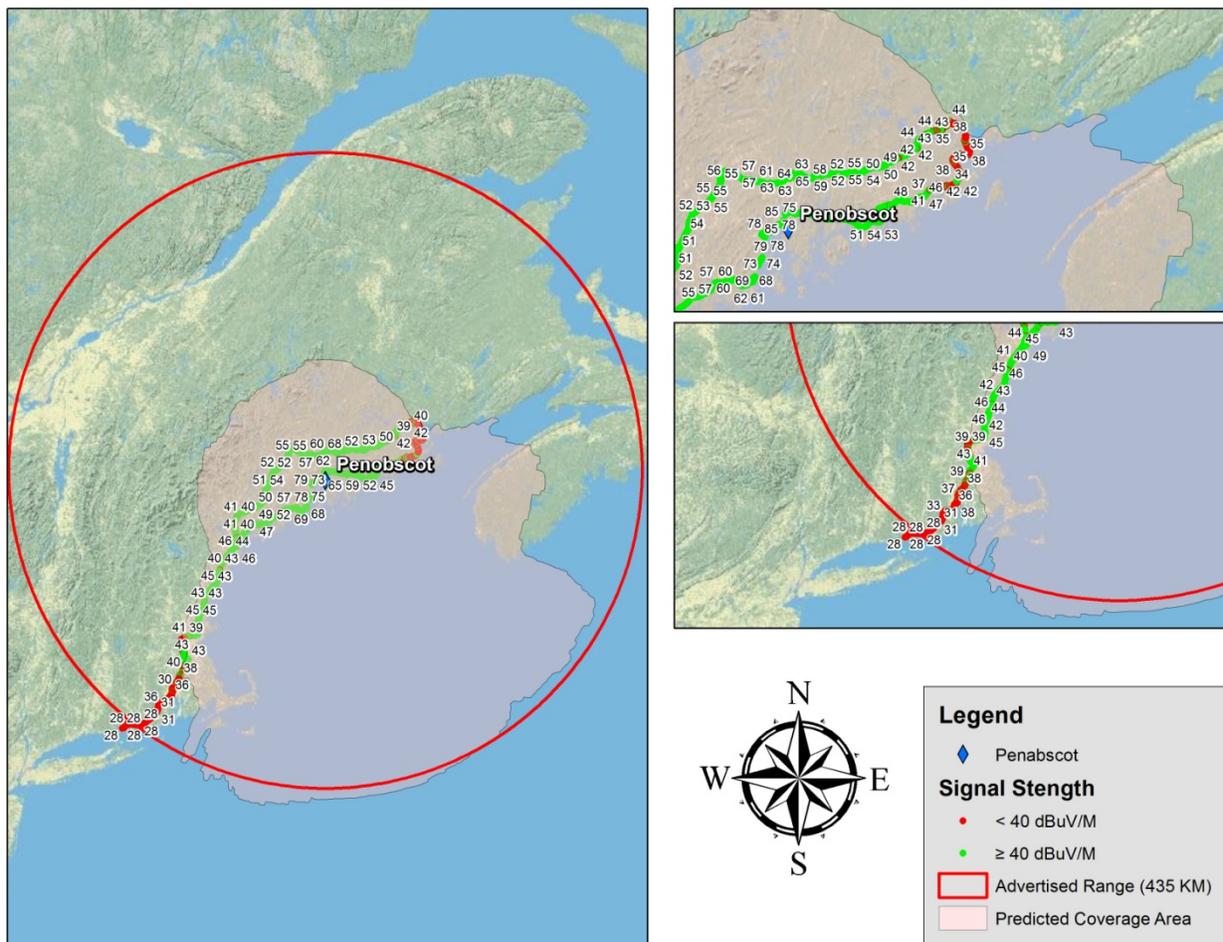


Figure 1: Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	35 dB $\mu$ V/m	15 dB $\mu$ V/m	41° 39' 32" N, 071° 32' 44" W
B	N/A	N/A	

Table 1: Northeast Far-Field Signal Strength Reading

Side	Signal Strength	Signal to Noise ratio	Position
A	36 dB $\mu$ V/m	20 dB $\mu$ V/m	45° 7' 25" N, 067° 8' 51" W
B	N/A	N/A	

Table 2: Southwest Far-Field Signal Strength Reading

**RTCM Message Verification**

Table 3 and Table 4 shows RTCM message scheduling, receipt, and content collected during the assessment. RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with the Reference (1). Receipt of all RTCM messages was validated utilizing a Remote Desktop Session whereby the assessment team witnessed the on-time receipt of all messages on the active and standby Integrity Monitor computers. All message content was verified and is in accordance with Reference (2).

Message Type	Received	Scheduled	Content Verified/Accurate
<i>Type 3</i>	Y	Y	Y
<i>Type 5 (ensure message is not being transmitted)</i>	N	N	N/A
<i>Type 7</i>	Y	Y	Y
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 3: Side A RTCM Message Validation

Message Type	Received	Scheduled	Content Verified/Accurate
<i>Type 3</i>	Y	Y	Y
<i>Type 5 (ensure message is not being transmitted)</i>	N	N	N/A
<i>Type 7</i>	Y	Y	Y
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 4: Side B RTCM Message Validation

**Accuracy Validation**

Positional data was collected for 12 minutes per side using the Trimble SPS461. The data was then post processed and compared to a National Geodetic Survey (NGS) marker (Table 5) to verify the horizontal accuracy of the broadcast correction (Table 6). Side A was 0.1138 m

meters, bearing 193.0569° from the monument. As per Reference (1) and (2), the distance was within advertised accuracy requirements. A comparison between the GPS satellites in view at the Penobscot DGPS site and at the NGS monument location was conducted (Table 7) to identify any differences in the GPS satellite geometry used at the respective locations; any differences in geometry could lead to accuracy discrepancies. In this case, the satellites being tracked by the Reference Station and Integrity Monitor GPS receivers at the site were almost identical to those tracked at the NGS monument location. A two dimension radial review of the same time period was completed for the Side A integrity monitor. Side A’s average deviation was 0.08239 meters; findings were consistent with the findings observed in the field and are well within system parameters

<b>NGS Monument ID:</b>	<b>BBCM85</b>
Monument LAT:	45° 7' 25.94681" N
Monument LON:	67° 8' 51.32938" W
Distance from DGPS Site	148 km

Table 5: NGS Monument ID

<b>Averaged LAT:</b>	45° 7' 25.9504" N
<b>Averaged LON:</b>	67° 8' 51.3282" W
<b>Distance from Monument:</b>	0.1138 m (0.37335958 ft)
<b>Bearing from Monument:</b>	193.0569°

Table 6: Side A Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>										
Reference Station A	2	5	6	9	12	17	23	25	29		
Integrity Monitor A	2	5	6	9	12	17	23	25			
Reference Station B	N/A										
Integrity Monitor B	N/A										
NGS Monument Location, Side A	2	5	6	9	12	17	23	25			
NGS Monument Location, Side B	N/A										

Table 7: GPS Satellite Comparison

**NAVGEN INTERNAL ONLY: The following information will be placed in an OA index for internal tracking purposes and removed before posting.**

***Discrepancies***

***Socket Failure on side B during the week of the OA***

**RECOMMENDATION**

No changes recommended.

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